

I claim:

- 1 1. An apparatus for generating narrow bandwidth picosecond optical pulses
- 2 comprising:
 - 3 a pump laser;
 - 4 an optical parametric oscillator pumped by a pump pulse train generated by the
 - 5 pump laser;
 - 6 an optical parametric amplifier having an input coupled to an output of the optical
 - 7 parametric oscillator and pumped by the pump laser,
 - 8 wherein the optical parametric oscillator comprises an optical cavity comprised of
 - 9 a grating-mirror termination on one end of the cavity and a cavity mirror on an opposing
 - 10 end of the cavity with optically nonlinear active media therebetween.
 - 11
 - 12 2. The apparatus of claim 1 where the grating-mirror termination on one end of the
 - 13 cavity is comprised of a grazing incidence grating and a tuning mirror, the grating and
 - 14 mirror being arranged with respect to each other so that a diffracted first order is
 - 15 reflected back from the mirror to the grating and into the cavity.
 - 16
 - 17 3. The apparatus of claim 2 where the grazing incidence grating has a periodicity of
 - 18 about equal to the groove spacing of the grating.

1 4. The apparatus of claim 2 where the cavity has an axis and where the grazing
2 incidence grating is inclined at an approximately 10° angle with respect to the axis.

1 5. The apparatus of claim 2 where the grazing incidence grating has a blaze
2 optimized for grazing incidence to maximize a first grating order of diffraction.

1 6. The apparatus of claim 2 where the cavity has an optical length and where the
2 tuning mirror is rotatable about a center defined about the grating so that the resonant
3 wavelength of the cavity can be adjusted without changing the optical length of the
4 cavity.

1 7. The apparatus of claim 1 where pulses in the optical parametric oscillator are
2 characterized by a bandwidth and where the pump laser introduces a train of pulses into
3 the optical parametric oscillator of sufficient strength to trigger a multiple number of
4 round trips of pulses in the cavity of the optical parametric oscillator in which each
5 reflection of a pulse from the grating-mirror termination narrows the bandwidth of the
6 pulse.

1 8. The apparatus of claim 1 where the cavity of the optical parametric oscillator
2 further comprises a concave mirror or lens to image light transmitted to and received
3 from the grating-mirror termination to increase stability of the cavity.

1 9. The apparatus of claim 8 where the light in the cavity is characterized by a
2 wavefront and where the wavefront at the ends of the cavity, including at the grating-
3 mirror termination, is flattened relative to the wavefront at the center of the cavity.

1 10. The apparatus of claim 1 where the grating-mirror termination couples a 0th order
2 diffraction of light from the cavity of the optical parametric oscillator into the optical
3 parametric amplifier.

11. The apparatus of claim 1 where the pump laser generates a single pulse, which
is input into the optical parametric amplifier to coincide with the last pulse of a pulse
train output by the optical parametric oscillator and coupled into the input of the optical
parametric amplifier.

12. The apparatus of claim 1 where the optically nonlinear active media is comprised
2 of at least one BBO crystal.

1 13. The apparatus of claim 12 where the optically nonlinear active media is
2 comprised of a pair of BBO crystals arranged with respect to each in a walk-off
3 compensating arrangement to extend power capability of the optical parametric
4 oscillator.

1 14. The apparatus of claim 13 where each BBO crystal is independently rotatable to
2 adjust an angular orientation of each BBO crystal in the cavity.

1 15. The apparatus of claim 1 where the optical parametric oscillator and optical
2 parametric amplifier in combination generate a pulse having a bandwidth characterized
3 by a Fourier limit with the bandwidth of the generated pulse being near the Fourier limit.

16. A method for generating a narrow bandwidth picosecond optical pulse comprising:

generating a pump laser pulse train;

pumping an optical parametric oscillator by the pump pulse train;

generating a pulse train output with a narrowed bandwidth and picosecond pulse width from the optical parametric oscillator by use of a grating-mirror termination on one end of a cavity in the optical parametric oscillator and a cavity mirror on an opposing

end of the cavity with optically nonlinear active media therebetween;

pumping an optical parametric amplifier having an input coupled to an output of

the optical parametric oscillator; and

outputting the narrow bandwidth picosecond optical pulse from the optical

parametric amplifier.

17. The method of claim 16 where the grating-mirror termination on one end of the cavity is comprised of a grazing incidence grating and a tuning mirror, and where generating a pulse train output with a narrowed bandwidth and picosecond pulse width

4 generates a diffracted first order reflected back from the mirror to the grating and into
5 the cavity.

1 18. The method of claim 17 further comprising providing the grazing incidence
2 grating with a periodicity such that the center wavelength is about a groove spacing.

1 19. The method of claim 17 where the cavity has an axis and further comprising
2 providing the grazing incidence grating with an inclination of an approximately 10° angle
with respect to the axis.
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4 the cavity of the optical parametric oscillator in which each reflection of a pulse from the
5 grating-mirror termination narrows the bandwidth of the pulse.

1 23. The method of claim 16 further comprising stabilizing the cavity of the optical
2 parametric oscillator by providing a concave mirror or lens in the cavity to image light
3 transmitted to and received from the grating-mirror termination to increase stability of
4 the cavity.

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1 27. The method of claim 16 where generating a pulse train output from the optical
2 parametric oscillator comprises generating the pulse train in at least one BBO crystal.

1 28. The method of claim 27 where generating a pulse train output from the optical
2 parametric oscillator comprises generating the pulse train in a pair of BBO crystals
3 arranged with respect to each in a walk-off compensating arrangement to extend power
4 capability of the optical parametric oscillator.

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